Montana’s dryland ecosystem is characterized by low annual quantity and poor distribution of precipitation, which makes dryland crop production particularly risky in Montana. With annual average precipitation oscillating between 12 and 14 inches, most of the soil water storage is depleted after a single crop has been grown. Confronted with this reality, winter wheat–fallow agricultural systems have been widely adopted to reduce the risk of crop failure. No-till combined with the fallow system (“chemfallow”) allows the conservation of water that had been stored in the soil profile. However, reduced risk goes along with reduced profit potential. The issue is the perception by the producer that leaving land fallowed is required to store soil moisture rather than grow crops. This perception stems from cases of pulse failure across Montana attributed to severe atmospheric (solar radiation, heat, and precipitation) and soil (moisture and temperature) climate conditions.

However, there are economic and environmental costs attached to fallowing: labor, fuel, and herbicide expenses may be aggravated by loss of topsoil through wind and water erosion. Although in many instances, crop–fallow is unavoidable (e.g., shallow soils, extremely low annual precipitation), it is not always the case. Geographic regions with substantial annual precipitation and deeper soils that could hold more water may be suited to continuous spring and fall cropping. The intensification of cropping systems based on winter wheat offers the potential for increased profitability while increasing farmers’ risk as well. When can farmers skip the fallow without substantially increasing the risk of crop failure? What tool, if any, can they use to help them make that decision?

Historically, producers have used empirical tools such as the soil probe to help them decide whether or not to skip the summer fallow. A hand-held probe is driven into the soil by the operator with the assumption that the deeper it goes into the ground, the wetter the soil is. The tool, although sometimes useful, lacks accuracy because the depth of penetration of the instrument into the soil doesn’t depend uniquely on soil moisture. Other factors such as the operator’s strength, texture and structure of the soil will influence the depth of penetration of the probe. Moreover, all the moisture in the soil profile at the onset of the growing season need not necessarily be available to the crop. Some of it may be lost through soil evaporation, which depends on atmospheric factors such as solar radiation, ambient temperature, relative humidity, and wind. Conversely, there might not be enough moisture at the beginning of the spring cropping season, but enough rain during the growing season to sustain both spring and winter growing seasons.

It is, therefore, imperative to develop new and accurate tools that account for not only soil moisture, but also meteorological variables such as solar radiation, ambient temperature, relative humidity, wind, and in-season precipitations. The development of such tools requires a system approach type of research that aims at determining how soil water content individually and in combination with meteorological variables influences individual and total yields of pea–winter wheat, lentils–winter wheat, and barley–winter wheat crop sequences.

An original and innovative experiment was set up in the fall 2015 at the Western Triangle Agricultural Research Center of Montana State University in Conrad (Fig. 1). The trial consisted of five strips of land (T1, T2, T3, T4, T5)